Content available at: https://www.ipinnovative.com/open-access-journals

Journal of Dental Specialities

Journal homepage: https://www.jdsits.in/



Review Article

3D analysis of effects of MARPE on skeletal, dental and airway structures – A systematic review

Swaroopa Rani Ponnada^{1,2}*o, Snigdha Pattanaik³, Pragnya Dittakavi², Chandrasekhar Gandikota², Smruti Bhusan Nanda¹

¹Dept. of Orthodontics, Shiksha O Anusandhan University, Bhubaneswar, Odisha, India

²Dept. of Orthodontics, Panineeya Mahavidyalaya Institute of Dental Sciences and Research Centre, Hyderabad, Telangana, India

³Dept. of Preventive and Restorative Dentistry, College of Dental Medicine, University of Sharjah, Sharjah, UAE

Abstract

Background: MARPE represents a non-surgical approach to treating transverse maxillary deficiency. Nevertheless, the available evidence regarding the effectiveness of MARPE is limited.

Objectives: This systematic review aims to evaluate the efficacy of MARPE on factors such as skeletal and dental transverse maxillary dimensions, success rate, maxillary sinus width, upper airway dimension, effects on obstructive sleep apnea and periodontium.

Materials and Methods: Four electronic databases were searched: PubMed, SCOPUS, Science Direct and COCHRANE with Publication date restriction from 2000 to till date.

Selection criteria: observational studies, non- randomized and randomized clinical trials done on patients aged up to 25 years with transverse maxillary deficiency, undergoing treatment with MARPE were considered.

Data collection and analysis: Inclusion eligibility screening, data extraction, and assessment of risk of bias were conducted independently.

Results: A total of seven articles were included in the study. MARPE showed a high success rate ranging from 83.9-100%, with significant skeletal transverse width increase (1.04- 3.37 mm) and intermolar dental width increase (2.85- 6.7 mm). A significant increase in the airway dimensions and apnea/hypopnea index was present (p<0.05). A significant decrease in the maxillary sinus width (-2.11 ± 0.72 mm) and the buccal plate thickness by 0.6 mm could be observed. **Conclusion:** MARPE has a high success rate as a treatment method in skeletal and dental expansion. As some amount of bias is associated with the studies selected further research involving superior quality is recommended.

Keywords: MARPE, Maxillary expansion, RME

Received: 06-02-2025; Accepted: 20-08-2025; Available Online: 29-09-2025

This is an Open Access (OA) journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprint@ipinnovative.com

1. Introduction

Transverse maxillary deficiency, a condition that is notably present among individuals seeking orthodontic treatment, may be observed in as much as 23.3% of the primary dentition population. This particular malocclusion tends to emerge during the growth and development of the face. If not intervened upon, it is likely to influence the permanent dentition, given the low probability of spontaneous correction. 2

Maxillary transverse deficiency, whether accompanied by posterior crossbite or not, can lead to various challenges for the patient. These may include varying degrees of occlusal disharmony, alterations in tongue posture, potential harm to periodontal structures such as local bone loss and gingival recession, functional shifts in the mandible due to improper buccolingual tipping of posterior teeth, asymmetric mandibular positioning in growing patients, joint disorders, muscle function disturbances, and insufficient space in the dental arch for proper dental alignment.³⁻⁵ However, a serious implication of maxillary transverse deficiency is the

*Corresponding author: Swaroopa Rani Ponnada Email: swaroopaponnada@gmail.com subsequent constriction of the nasal cavity, raising the nasal air resistance and could potentially contribute as an etiological factor to obstructive sleep apnea syndrome.^{6,7}

The use of tooth-borne expanders within Rapid Palatal Expansion (RPE) has proven effective in treating individuals with maxillary transverse deficiency. As patients undergo growth, there is a gradual process of calcification and interdigitation of craniofacial sutures, including the midpalatal suture and performing Rapid Palatal Expansion (RPE) becomes more challenging due to heightened mechanical resistance from these structures. In Therefore, Side effects including bone dehiscence or fenestration, gingival recession, root resorption, posterior teeth buccal tipping, and relapse are more common as the skeletal expansion decreases. Is Is Ishara and Staley reported that the most favorable age for tooth-borne maxillary expansion is before 13–15 years, as outcomes become less predictable and less stable in older patients.

Surgically-assisted rapid palatal expansion (SARPE) is often indicated to the older patients with transverse maxillary deficiencies. This procedure increases expansion predictability and success, and reduces its side effects.14 SARPE technique involves a LeFort I osteotomy combined with the surgical rupture of the midpalatal suture reducing the mechanical resistance to lateral forces applied by Hyrax expanders, typically anchored to the first molars and first premolars. Despite its advantages, SARPE raises both biological and financial costs of treatment. The procedure necessitates hospitalization and general anesthesia, potentially discouraging patients from opting for surgicalorthodontic treatment.15

As a result, some authors have explored the use of orthodontic micro implants as supplementary anchorage devices to enhance the application of mechanical forces to circum-maxillary sutures, eliminating the necessity for otherwise essential osteotomies. ¹⁶ This system, known as micro-implant-assisted rapid palatal expansion (MARPE), directs forces towards the micro-implants rather than applying pressure to the teeth or periodontium. Its design aims to optimize skeletal effects while minimizing dentoalveolar effects during expansion. ¹⁷ MARPE has received wide spread attention in recent years and several researchers have studied the efficacy of MARPE. However, to our knowledge, a systematic review on many factors influencing MARPE and its results on various anatomical structures has not yet been published.

This review aims to investigate the efficacy of MARPE by assessing various outcomes such as: achieved skeletal and dental expansion, upper airway expansion, maxillary sinus width, effects of MARPE on obstructive sleep `apnea and the periodontium.

2. Materials and Methods

2.1. Protocol and registration

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, this systematic review adheres to established reporting standards. The review protocol was registered with PROSPERO under the unique registration number CRD42024516523. Further information about the protocol can be accessed at https://www.crd.york.ac.uk/

2.2. Eligibility criteria

In accordance with the study objectives, studies involving adolescents and adults aged upto 25 years with transverse maxillary deficiency, undergoing treatment with RPE and MARPE, including all variations of MARPE appliance designs, whether hybrid tooth-bone-borne or solely bone-borne, as well as all types of expansion protocols were considered. However, Eligible studies needed to report on the outcomes such as skeletal and dental expansion, upper airway expansion, maxillary sinus width, effects of MARPE on obstructive sleep apnea and periodontium.

Both randomized and non-randomized clinical trials and observational studies, whether prospective or retrospective, were considered eligible for inclusion in the review. Exclusion criteria comprised studies involving individuals with cleft lip and palate or craniofacial anomalies, those with a history of maxillofacial surgery, and in vitro simulations such as Finite Element Method (FEM) analyses.

2.3. Information sources and search strategy

A comprehensive search strategy was formulated in collaboration with an experienced post graduate teacher from Public health Dentistry department. For the selection of search terms, PICOS questions were made which included MARPE in orthodontics, MARPE in young adults, palatal expansion, non-surgical techniques, study designs incorporated were case control studies, cohort studies, nonrandomized control trials and randomized control trials. Four electronic databases were searched: PUBMED, SCOPUS, Science Direct and COCHRANE. Same search terms were used for all data bases. Language restriction with only English was applied. Publication date restriction from 2000 to till date was considered. Detailed PRISMA flow chart and search strategy are attached in Figure 1 and Table 1 respectively.

2.4. Study selection

Three investigators were involved in the study selection process (S.P, P.D, S.P). The selection process was carried out using Rayyan (a web-based software platform that helps in protocol development, import and export of searched articles and duplicate removal, thereby helping in streamlining the production of high-quality systematic reviews). After removal of duplicates, each retrieved record was assessed by

two independent observers based on predefined eligibility criteria. All articles full texts were thoroughly studied and evaluated.

2.5. Data items and collection

Data extraction was conducted independently by two researchers (S.P, P.D). Any differences between the opinion of two researchers were discussed and dissolved. The extracted data was further evaluated by another researcher (S.P) for confirmation.

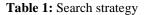
2.6. Risk of bias assessment in individual studies

JBI critical appraisal tool for assessment of risk of bias for cohort, cases control and for randomized control trials was used. The assessment is tabulated and attached.

3. Results

3.1. Success rate of MARPE

Three articles out of the total seven reported the success rate of MARPE which ranged from 83.9% - 100%. Only one study reported the success rate of MARPE as 100%



Identification	Records identified from: Databases (n=312) PubMed: 122 Scopus: 71	Records screened for studies published in English in the last 10-year period. (Excluded: n=22)
Screening	Science Direct: 109 Cochrane: 10 No of screened Records (n=290)	Records excluded after applying inclusion and exclusion criteria: Review articles: 70 Duplicates: 87 Not within the scope of the review: 48 Lack of access to full text =54
Eligibility	Full text articles assessed for eligibility (n=31)	Records excluded (n=26) FEM studies (n=8) Cleft lip and palate cases (n=5) Surgical cases (n=9)
Included	Studies included in Qualitative synthesis (n=7) Studies included in final review (n=7)	Cortico-puncture cases excluded (n=2)

Figure 1: PRISMA Flow chart

Database	Date of last	Filters applied	Keywords
	search		
Pubmed	11-02-2024	Case reports, case series, clinical studies, RCTs, English, articles published in last 10 years, free full text.	Marpe or mini implant or assisted or rapid maxillary expansion or orthodontics
Scopus	11-02-2024	Case reports, case series, clinical studies, RCTs, English, articles published in last 10 years, free full text.	Marpe or mini implant or assisted or rapid maxillary expansion or orthodontics
Cochrane	11-02-2024	Case reports, case series, clinical studies,	Marpe or mini implant or assisted or
Central Library		RCTs, English, articles published in last 10 years, free full text.	rapid maxillary expansion or orthodontics
Science Direct	11-02-2024	Case reports, case series, clinical studies,	Marpe or mini implant or assisted or
		RCTs, English, articles published in last 10	rapid maxillary expansion or
		years, free full text.	orthodontics

Table 2: JBI critical appraisal tool for assessment of risk of bias for RCT

Studies	Q1	Q2	Q3	Q4	Q5	Q6	Q 7	Q8	Q9	Q10	Q11	Q12	Q13
Choi et al. 2023 ¹⁸	Y	N	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Chun et al 2022 ²³	Y	N	Y	N	N	N	N	Y	Y	Y	Y	Y	Y
Aneris et al 2023 ¹⁹	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y
Jia et al 2021 ²⁴	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y
Brunetto et al, 2022 ²⁶	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y

Table 3: JBI critical appraisal tool for assessment of risk of bias for cohort studies

Studies	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Vo et al 2021 ²²	Y	Y	Y	N	Y	Y	Y	Y	Y

Table 4: JBI critical appraisal tool for assessment of risk of bias for case control studies

Studies	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Mehta et al 2022 ²⁰	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

3.2. Skeletal transverse maxillary expansion

Five articles have reported the skeletal transverse maxillary expansion. A variety of measurements were used for the assessment of skeletal transverse expansion. Nasal width, nasal base width, mid palatal suture separation, inter processus zygomaticus width, frontozygomatic suture–FZS, zygomaticomaxillary suture–ZMS, nasopalatine foramen–NPF, greater palatine foramen–GPF, maxillary basal bone width were the different measurements used across the studies. The mean skeletal expansion was statistically significant in all the five articles. Only one study reported the skeletal to dental expansion ratio of MARPE of about 61.4%

3.3. Dental transverse maxillary expansion

Dental transverse maxillary expansion was reported in five articles. A variety of measurements using the intermolar widths (IMW) and inter-canine (ICW) widths were used across these studies. The mean ICW ranged from 1.78-3.70 mm, mean interdental width at the premolar area ranged from 6.1-6.3 mm and the mean IMW ranged from 2.85- 6.7 mm. Measurements in all the studies were statistically significant.

3.4. Maxillary sinus width

Only one article reported the maxillary sinus width in the RPE.²³ An increase in nasal width decreased maxillary sinus

width with a mean reduction of - 2.11 ± 0.72 mm. This cha0nge was statistically significant.

3.5. Upper airway dimension

One article studies the effects of MARPE on retropalatal and retroglossal airway dimensions and minimal transverse constriction. Volumetric measurement of the upper airway segments was carried out. There was a statistically significant increase for all volumetric parameters and minimal transverse airway constriction (P < 0.05) between the preand post -expansion periods.

3.6. Effect on obstructive sleep apnea

Only one of the five articles, studies the effects of MARPE on obstructive sleep apnea in adults.²² Statistically significant improvements on the apnea/hypopnea index (65.3%), mean oxygen saturation, snoring duration, and bruxism to apnea index could be observed.

3.7. Periodontal effects

Only one article studied the periodontal effects of MARPE on bone.²⁴ The buccal and palatal bone plate thickness were measured at the premolar and molar areas for the assessment of the periodontal effects of MARPE. There was a decrease in the mean buccal plate thickness by 0.6 mm and the value was statistically significant.

Table 5:

Author Year & country	Study design	Sample size, sex, age (range, mean ± SD	Data collection	Intervention: appliance type, location, tads	Intervention: expansion protocol	Outcome
Choi et al. 2023, south korea ¹⁸	Randomized clinical trial	Total N= 36 Included N= 31 12f, 19m 19-35 years 23.6 ±4.4	CBCT Images at T1 - pre - treatment T2- immediately after removal of appliance	modified Hyrax- type expander (HyraxII; Dentaurum, Ispringen, Germany) N=4 TADS (diameter, 1.5 mm; self-drilled type; BMK, Biomaterials Korea, Seoul, Republic of Korea; L= anterior -6 or 13mm, posterior – 8 or11 mm	0.2 mm activation per day. Retention phase of 3 months following active expansion	Skeletal linear measurements Interalare width, Interprocessus zygomaticus width Dentoalveolar linear measurements Interectocanine width, Interectomolare width, Interfurcation width, Interfurcation width, Intercentral fossa width Dental angular measurements Right first molar, right first premolar, Left first molar, Left first premolar The success rate of the midpalatal suture separation and the stability of the miniscrews at the time of the MARPE removal were considered secondary outcomes

Aneris et al.20923. Brazil ¹⁹	Randomized clinical trial	Total N= 187 Included= 20 4m, 16f 18 years or older 24.5 ± 6.2 years	CBCT images at T0- pretreatment T1- after 120 days post expansion	MARPE type appliances with expander screws (PecLab Belo Horizonte, MG, Brazil) N=4 TADS used	Retention phase for 120 days following active expansion	airway volumes for the total upper, retropalatal, and retroglossal airways, minimal transverse airway constriction
Mehta et al. 2022. USA ²⁰	Retrospective study	Total N= 60 11-15 years 13.69 ± 1.74 years	CBCT images at T1-pretreatment T2- post expansion T3- post treatment	MARPE appliance N= 2 TADS L= 12mm D= 1.5mm, Straumann GBR System, Andover, Mass; a tooth- borne expander anchored to the molars and premolars	two turns per day (0.25 mm per turn, 0.5 mm per day	Nasal height (NH), nasal length (NL), nasion–ANS height (NAH), ANS–PNS length (APL), pyriform height (PH), and nasal septal deviation angle (NSDA), alar width (AW), alar base width (ABW), anterior nasal cavity width (ANCW), posterior nasal cavity width (PNCW), maxillary intermolar width (IMW), and maxillary intercanine width (ICW)
Brunetto et al. 2022. Brazil ²¹	Randomized clinical trail	N=32 18 years or above	CBCT images at T1= pretreatment T2- immediately after last expansion	MSE expander N= 4 TADS L= 9, 11, 13 mm D= 1.5 mm	0.5–1 mm per day until the interincisal diastema appears, and after that 0.25–0.5 mm per day, Retention phase of 3 months following active expansion	Epworth Sleepiness Scale (EES) and Quebec Sleep Questionnaire (QSQ), and home sleep testing (HST)
Vo et al. 2021. Vietnam ²²	Prospective study	N=30 6-16 years	CBCT images at T1 - pre-treatment T2 - after one month of maxillary expansion	a Hyrax-type RPE -Rapid palatal expander	Activation for one month, the mean extensibility of the RME screw -7,25 ± 1,40 mm	Maxillary and mandibular arch widths at the positions of canines (C-3), first premolars (D-4), and first molars (6-6). IMW: Inter Molar Width, DP: Depth of the palate, NW: Nasal width, NFW: Nasal floor width, Maxillary sinus width (MSW), ossification degree of the mid-palatal suture
Chun et al. 2022. South Korea ²³	Randomized clinical trial	Total N= 51 Included N= 40 14m, 26f 7-25 years 14±4.2 years	CBCT images at T0-pretreatment T1-immediately after expansion T2- after 3month consolidation	Tooth-borne RPE- Hyrax expander (Dentaurum, Ispringen, Germany) with bands on first premolars and molars and MARPE- hyrax screw with N=4 TADS L - 7or 9 mm D- 1.8 mm	One-quarter of a turn (0.20 mm/turn), activated 35 times, which corresponded to 7.0 mm of hyrax screw expansion. After active expansion, a retention phase of months was followed	Skeletal (frontozygomatic suture–FZS, zygomaticomaxillary suture–ZMS, nasal width–NW, nasopalatine foramen– NPF, greater palatine foramen–GPF, and midpalatal suture– MPS), dentoalveolar (maxillary width–MW, interdental width–IDW,

Jia et al. 2021 Randomized China ²⁴ Clinical Trial China ²⁴ Randomized Clinical Trial Stellar Stella
Jia et al. 2021 Randomized China ²⁴ Clinical Trial 21m, 39f images at T1- before expansion and T2- one week after expansion manatomic expansion anatomic expansion at SE_PNS expansion at SE_PNS expansion at SE_PNS expansion at Alveolar-
Jia et al. 2021 Randomized China ²⁴ China ²⁴ Randomized clinical Trial Skeletal- NW width, Maxillary basal tubes, and two and 3 months of and T2- one week after expansion Width, Maxillary basal width; SE of expansion Width, Maxillary basal width; SE of expansion Width, SE of expansion Width, Maxillary basal width; SE of expansion Width, Width, SE of expansion Width,
Two-quarter turns (1808, 0.5 width, Maxillary basal tubes, and two and T2- one week after expansion week after expansion anatomic expansion anatomic expansion at SE_PNS expansion at SE_PNS expansion at SE_PNS expansion at SE_PNS expansion at NARPE appliance- turns (1808, 0.5 width, Maxillary basal width; SE sepansion at SE_PNS expansion at PNS
China ²⁴ clinical Trial 21m, 39f 12-18 years 15.1 ± 1.6 images at T1- before expansion and T2- one week after expansion molars. The jackscrew (length: 12 mm; anatomic expansion at SE_PNS expansion at PNS expan
12-18 years 15.1 ± 1.6 before expansion and T2- one week after expansion mm) per day and 3 months of vidth; SE sepansion midpalatal sepansion mm) per day and 3 months of retention. mm) per day and 3 months of vidth; SE sepansion midpalatal sepansion at SE ANS sepansion at SE PNS sepansion at PNS anatomic expander type:
expansion and T2- one week after expansion expansion week after expansion anatomic expansion and T2- one week after expansion were expa
and T2- one week after expansion molars. The jackscrew (length: 12 mm; anatomic expansion at PNS expansion at PNS expansion at type:
week after expansion molars. The jackscrew (length: 12 mm; anatomic expansion at PNS expans
expansion molars. The jackscrew expansion at (length: 12 mm; anatomic expander type: Alveolar-
jackscrew (length: 12 mm; anatomic expansion at PNS expansion at PNS expander type:
(length: 12 mm; anatomic expansion at PNS expander type: Alveolar-
anatomic expansion at PNS expander type: Alveolar-
expander type: Alveolar-
Pforzheim, width AH Al
Germany) Four height custom stainless- Dental- IAW
steel tubes Apex Width, (internal Inter-Crown V
diameter: 2.0 TI M1
mm; external inclination of
diameter: 3.0 molars, TI P1
mm; length: 3.0 inclination of
mm). N=4 TADS premolars Applia
L-12mm, D- 1.7 AE App
mm expansion

4. Discussion

The aim of the present systematic review was to assess the various effects of MARPE in adolescents and young adults aged upto 25 years. A total of seven studies have met the eligibility criteria and were included in the review after the assessment of the risk of bias. 19-25 While there were slight variations in the definition of successful expansion among the included studies, a common consensus considered expansion satisfactory when the occlusal aspect of the lingual cusp of the maxillary first molars came into contact with the occlusal aspect of the buccal cusp of the mandibular first molars. 26 The success rate of MARPE ranging from 83.9%-100% was reported in three out of the seven articles considered in the systematic review. However only one study reported the success rate of 100%.

Skeletal transverse maxillary expansion was reported by five articles. Considerable variation existed among the measurements used across these studies for the assessment of transverse skeletal expansion. Nasal width, nasal base width, mid palatal suture separation, inter processus zygomaticus width, frontozygomatic suture–FZS, zygomaticomaxillary suture–ZMS, nasopalatine foramen–NPF, greater palatine foramen–GPF, maxillary basal bone width were the different measurements used across the studies. The mean skeletal transverse expansion ranged from 1.04-3.37 mm considering the nasal width across all the five articles. The values are statistically significant in all the studies but are not clinically

different from the mean skeletal expansion of 3.3 mm produced by SARPE.²⁷

Dental transverse maxillary expansion was reported in five out of seven articles. Slices of CBCT images and volumetric CBCT images were used for the measurements of the widths. Only one article has used dental casts for the measurements of the widths. These articles found that the mean increase in the ICW and IMW ranged from 1.78-3.70 mm and 2.85-6.7 mm respectively. In contrast, SARPE demonstrated a statistically larger mean increase in intermolar width (MD: 7.0 mm, 95% CI: 6.1 mm-7.8 mm) compared to MARPE, although the clinical difference was not significant.²⁷ Only one study provided information on the ratio of skeletal to dental expansion achieved through MARPE, indicating a notable proportion of approximately 61.4%.

From the other outcome measures, an article by Vo et al. 23 reported the maxillary sinus width after the rapid palatal expansion. Maxillary sinus width (MSW) was the width of the maxillary sinus on the extension of the nasal width. An augmentation in nasal width was associated with a concurrent reduction in maxillary sinus width, demonstrating a statistically significant mean decrease of -2.11 ± 0.72 mm (p < 0.05) which is comparable to the previous study reporting -1.45 ± 1.77 mm reduction in the maxillary sinus width. 28

The effects of MARPE on upper airway dimensions was reported in one article by Aneris et al.²⁰ This study reported

the effects of MARPE on the total, retropalatal, retroglossal airway dimensions and minimal transverse constriction. In this study, it was evidenced that MARPE therapy led to a significant enhancement in volumetric parameters within the upper airway spaces. Specifically, the upper airway volume exhibited an average increase of approximately 14%. This outcome is consistent with the results of a prior study that documented a rise in nasopharyngeal volume of around 8.48%.²⁹ This finding illustrates a similarity in the secondary response of MARPE to the outcomes observed in both conventional RME in children and surgically assisted RME in adults.³⁰⁻³²

The effects of MARPE on obstructive sleep apnea was reported in one study by brunetto et al.²² Epworth Sleepiness Scale (ESS) and Ouebec Sleep Ouestionnaire (OSO); Home Sleep Test (HST); Cone Beam Computed Tomography (CBCT) were some of the examinations used across this study. The intervention group exhibited a statistically significant average reduction of 65.3% in the Apnea-Hypopnea Index (AHI). However, a study by Vinha et al. discovered a 56% average reduction in the Apnea-Hypopnea Index (AHI) among SARPE patients who underwent Le Fort I and mid-palatal osteotomies.³³ In a recent study, Liu et al. identified an average reduction of 54% in the Apnea-Hypopnea Index (AHI) among 20 non-obese adult patients who underwent maxillary distraction osteogenesis.³⁴ Therefore, MARPE demonstrated to be a successful alternative treatment modality for the obstructive sleep apnea as compared to SARPE and Distraction osteogenesis.

Only one study by chun et al.23 has reported the periodontal effects of MARPE by measuring the buccal bone plate thickness (BBPT) and palatal bone plate thickness (PBPT) at the premolar and molar regions. Following RPE and MARPE expansion, there was an observed mean decrease in buccal bone thickness of the first molars by 0.6 mm with the measurements ranging approximately from 0.4– 0.7 mm. In contrast, palatal bone thickness exhibited an increase of 0.5-0.9 mm immediately after the expansion procedures. These findings suggest a buccal displacement of the anchor teeth within the alveolar bone. The BBPT was reduced significantly in the molar area in the RPE group as compared to the MARPE group in the consolidation phase. This suggests that, for a given amount of expansion, the MARPE group experiences a reduced buccal displacement of the anchor teeth within the alveolar bone compared to other groups. These results are consistent with the study done by Garib et al. which documented that RPE resulted in buccal bone dehiscences, particularly on the anchorage teeth, especially in individuals with thinner buccal bone plates.³⁴

5. Conclusion

This review concluds that MARPE has a higher success rate (83.9-100%) in skeletal (1.04- 3.37 mm) as well as dental expansion (2.85- 6.7 mm). These results have no significant differences from the expansion achieved by SARPE.

Furthermore, it has been demonstrated that MARPE has led to a significant increase in the retroglossal, retropalatal airway dimensions and apnea/hypopnea index. However, there exists a scarcity of evidence indicating that MARPE may affect the dental and periodontal tissues by causing decrease in the buccal plate thickness.

Given the substantial risk of bias observed in most of the studies included, it is crucial to interpret the data with caution. Conducting randomized clinical trials and prospective cohort studies is recommended to further enhance evidence on MARPE sefficacy.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

- Kurol J, Berglund L. Longitudinal study and cost-benefit analysis of the effect of early treatment of posterior cross-bites in the primary dentition. Eur J Orthod. 1992;14(3):173–9.
- da Silva Filho OG, Santamaria-Jr M, Filho LC. Epidemiology of posterior crossbite in the primary dentition. *J Clin Pediatr Dent*. 2007;32(1):73–8.
- McNamara JA, Lione R, Franchi L, Angelieri F, Cevidanes LH, Darendeliler MA, et al. The role of rapid maxillary expansion in the promotion of oral and general health. *Prog Orthod*. 2015:16:33.
- Aloufi F, Preston CB, Zawawi KH. Changes in the upper and lower pharyngeal airway spaces associated with rapid maxillary expansion. ISRN Dent. 2012:2012:290964.
- De Rossi M, De Rossi A, Hallak JE, Vitti M, Regalo SC. Electromyographic evaluation in children having rapid maxillary expansion. Am J Orthod Dentofacial Orthop. 2009;136(3):355–60.
- Alexander NS, Schroeder JW. Pediatric obstructive sleep apnea syndrome. Pediatr Clin North Am. 2013;60(4):827–40.
- Vidya VS, Sumathi FA. Rapid maxillary expansion as a standard treatment for obstructive sleep apnea syndrome: A systematic review. J Dental Med Sci. 2015;14(2):51–5.
- Bishara SE, Staley RN. Maxillary expansion: clinical implications. *Am J Orthod Dentofacial Orthop*. 1987;91(1):3–14.
- Bazargani F, Feldmann I, Bondemark L. Three-dimensional analysis
 of effects of rapid maxillary expansion on facial sutures and bones:
 a systematic review. Angle Orthod. 2013;83(6):1074

 –82.
- Melsen B, Melsen F. The postnatal development of the palatomaxillary region studied on human autopsy material. Am J Orthod. 1982;82(4):329–42.
- 11. Persson M, Thilander B. Palatal suture closure in man from 15 to 35 years of age. *Am J Orthod*. 1977;72(1):42–52.
- Garib DG, Henriques JF, Janson G, de Freitas MR, Fernandes AY. Periodontal effects of rapid maxillary expansion with tooth-tissueborne and tooth-borne expanders: a computed tomography evaluation. Am J Orthod Dentofacial Orthop. 2006;129(6):749–58.
- Lione R, Franchi L, Cozza P. Does rapid maxillary expansion induce adverse effects in growing subjects?. Angle Orthod. 2013;83(1):172-82.
- Northway WM, Meade-Jr JB. Surgically assisted rapid maxillary expansion: a comparison of technique, response, and stability. *Angle Orthod.* 1997;67(4):309–20.
- Stuart DA, Wiltshire WA. Rapid palatal expansion in the young adult: time for a paradigm shift?. J Can Dent Assoc. 2003;69(6):374–7.

- Carlson C, Sung J, McComb RW, Machado AW, Moon W. Microimplant-assisted rapid palatal expansion appliance to orthopedically correct transverse maxillary deficiency in an adult. Am J Orthod Dentofacial Orthop. 2016;149(5):716–28.
- Choi SH, Shi KK, Cha JY, Park YC, Lee KJ. Nonsurgical miniscrew-assisted rapid maxillary expansion results in acceptable stability in young adults. *Angle Orthod*. 2016;86(5):713–20.
- Choi EH, Lee KJ, Choi SH, Jung HD, Ahn HJ, Deguchi T, Cha JY. Skeletal and dentoalveolar effects of miniscrew-assisted rapid palatal expansion based on the length of the miniscrew: a randomized clinical trial. *Angle Orthod*. 2023;93(4):390–7.
- Anéris FF, El Haje O, Rosário HD, de Menezes CC, Franzini CM, Custodio W. The effects of miniscrew-assisted rapid palatal expansion on the upper airway of adults with midpalatal suture in the last two degrees of ossification. *J World Fed Orthod*. 2023;12(4):150–5.
- Mehta S, Gandhi V, Vich ML, Allareddy V, Tadinada A, Yadav S. Long-term assessment of conventional and mini-screw-assisted rapid palatal expansion on the nasal cavity. *Angle Orthod*. 2022;92(3):315–23.
- Brunetto DP, Moschik CE, Dominguez-Mompell R, Jaria E, Sant'Anna EF, Moon W. Mini-implant assisted rapid palatal expansion (MARPE) effects on adult obstructive sleep apnea (OSA) and quality of life: a multi-center prospective controlled trial. *Prog* Orthod. 2022;23(1):3.
- Vo HT, Tran LT, Nguyen HT. Dental and skeletal changes on conebeam computed tomography after rapid maxillary expansion using rapid palatal expander for the growing children. *Oral Maxillofac* Surg Cases. 2021;7(4):100237.
- Chun JH, de Castro AC, Oh S, Kim KH, Choi SH, Nojima LI, et al. Skeletal and alveolar changes in conventional rapid palatal expansion (RPE) and miniscrew-assisted RPE (MARPE): a prospective randomized clinical trial using low-dose CBCT. BMC Oral Health. 2022;22(1):114.
- Jia H, Zhuang L, Zhang N, Bian Y, Li S. Comparison of skeletal maxillary transverse deficiency treated by microimplant-assisted rapid palatal expansion and tooth-borne expansion during the postpubertal growth spurt stage: A prospective cone beam computed tomography study. *Angle Orthod*. 2021;91(1):36-45.
- Lim HM, Park YC, Lee KJ, Kim KH, Choi YJ. Stability of dental, alveolar, and skeletal changes after miniscrew-assisted rapid palatal expansion. *Korean J Orthod*. 2017;47(5):313–22.

- Bortolotti F, Solidoro L, Bartolucci ML, Incerti Parenti S, Paganelli C, Alessandri-Bonetti G. Skeletal and dental effects of surgically assisted rapid palatal expansion: a systematic review of randomized controlled trials. *Eur J Orthod*. 2020;42(4):434-40.
- Garrett BJ, Caruso JM, Rungcharassaeng K, Farrage JR, Kim JS, Taylor GD. Skeletal effects to the maxilla after rapid maxillary expansion assessed with cone-beam computed tomography. Am J Orthod Dentofacial Orthop. 2008;134(1):8–9.
- Yi F, Liu S, Lei L, Liu O, Zhang L, Peng Q, et al. Changes of the upper airway and bone in microimplant-assisted rapid palatal expansion: A cone-beam computed tomography (CBCT) study. J Xray Sci Technol. 2020;28(2):271–83.
- Ballanti F, Lione R, Baccetti T, Franchi L, Cozza P. Treatment and posttreatment skeletal effects of rapid maxillary expansion investigated with low-dose computed tomography in growing subjects. Am J Orthod Dentofacial Orthop. 2010;138(3):311–7.
- Suzuki H, Moon W, Previdente LH, Suzuki SS, Garcez AS, Consolaro A. Miniscrew-assisted rapid palatal expander (MARPE): the quest for pure orthopedic movement. *Dent Press J Orthod*. 2016;21(4):17–23.
- Fastuca R, Perinetti G, Zecca PA, Nucera R, Caprioglio A. Airway compartments volume and oxygen saturation changes after rapid maxillary expansion: a longitudinal correlation study. *Angle Orthod*. 2015;85(6):955–61.
- Vinha PP, Eckeli AL, Faria AC, Xavier SP, de Mello-Filho FV. Effects of surgically assisted rapid maxillary expansion on obstructive sleep apnea and daytime sleepiness. Sleep Breathing. 2016;20(2):501–8.
- Liu SY, Guilleminault C, Huon LK, Yoon A. Distraction osteogenesis maxillary expansion (DOME) for adult obstructive sleep apnea patients with high arched palate. *Otolaryngol Head Neck Sur.* 2017;157(2):345–8.
- Garib DG, Henriques JF, Janson G, de Freitas MR, Fernandes AY. Periodontal effects of rapid maxillary expansion with tooth-tissueborne and tooth-borne expanders: a computed tomography evaluation. Am J Orthod Dentofac Orthopedics. 2006;129(6):749– 58

Cite this article: Ponnada SR, Pattanaik S, Dittakavi P, Gandikota C, Nanda SB. 3D analysis of effects of MARPE on skeletal, dental and airway structures – A systematic review. *J Dent Spec*. 2025;13(2):177-184.